

# Asteroid Icy Regolith Excavation and Volatile Capture Project

Center Independent Research & Developments: KSC IRAD Program | Science Mission Directorate (SMD)



## ABSTRACT

Icy regolith simulants will be produced in a relevant vacuum environment using various minerals, including hydrated minerals, that are found in C-type meteorites and in other types of planetary regolith. This will allow us to characterize the mechanical strength of the icy regolith as a function of ice content using penetration, excavation, and sample capture devices. The results of this study will benefit engineers in designing efficient regolith excavators and ISRU processing systems for future exploration missions to asteroids and other planetary bodies.

## ANTICIPATED BENEFITS

### To NASA funded missions:

This project fundamentally changes NASA's ability to understand the soil mechanics and the forces required to drill, sample, and excavate icy regolith in a relevant environment.

NASA's Return on Investment: NASA's technology development for icy planetary surface missions cannot be completed without this new capability. The results will enable the acceleration of technological know-how and science related to planetary icy regolith and will result in state-of-the-art capabilities for NASA and outside customers.

Non-NASA benefits – (commercial applications, etc.)

The rapid emergence of commercial ventures aimed at exploiting space resources creates potential users of the new capabilities and the related technologies.

### To the commercial space industry:

The technology will benefit the future commercial space mining community with designing efficient regolith excavators and



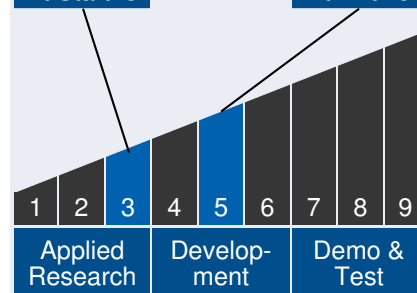
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## Technology Maturity

At Start: 3

At End: 5



## Management Team

### Project Manager:

- Nancy Zeitlin

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drilling technologies for use on asteroids and other planetary bodies.

## DETAILED DESCRIPTION

This study will help to inform engineers designing regolith excavators and ISRU processing systems for future exploration missions to asteroids and other planetary bodies. Icy regolith simulants will be produced in a relevant vacuum environment using various minerals, including hydrated minerals, that are found in C-type meteorites and in other types of planetary regolith. This will allow us to characterize the mechanical strength of the icy regolith as a function of ice content using penetration, excavation, and sample capture devices.

The project utilizes technologies developed under a FY14 project to excavate and measure the mechanical properties of icy regolith under relevant atmospheric conditions. The earlier project tested icy regolith using a 1/8 scale test setup and also developed a full-scale test system for regolith excavation, sample capture and soil mechanics studies. Technical challenges include preparing icy regolith at cryogenic temperatures inside a vacuum chamber, and controlling the environmental conditions, i.e., low temperature and high-vacuum pressure.

Key project objectives:

Use the novel methods developed under an earlier project that produced mixtures of ice and lunar (or Martian) regolith simulant under low pressure in an existing laboratory vacuum chamber at KSC. In this project, we will use other planetary regolith simulants including BP-1 and especially asteroid simulants that will be developed in collaboration with the University of Central Florida's Center for Lunar and Asteroid Surface Science

### Management Team (*cont.*)

#### Principal Investigator:

- James Mantovani

#### Co-Investigators:

- Adam Swanger
- Ivan Townsend

### Technology Areas

#### Primary Technology Area:

In-Situ Resource Utilization (TA 7.1)

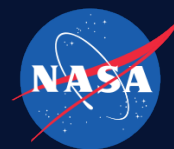
└ Resource Acquisition (TA 7.1.2)

#### Other Technology Areas:

- In-Situ Instruments / Sensor (TA 8.3)

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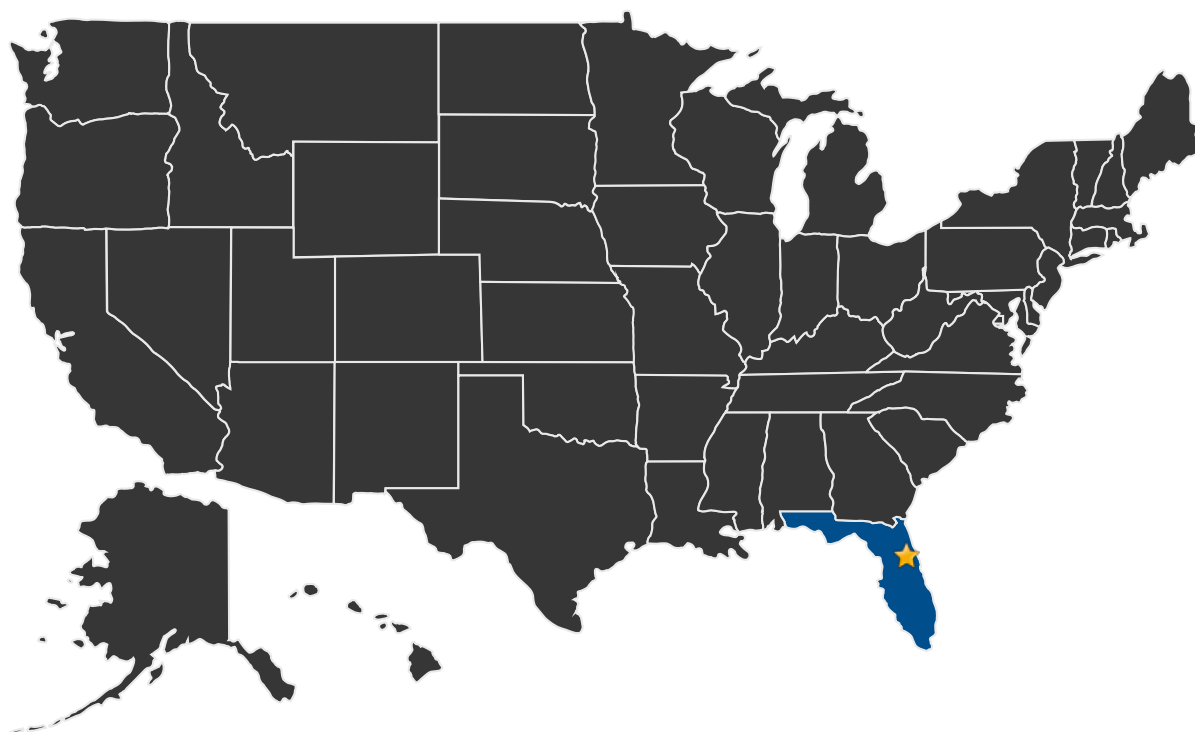
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(CLASS) which is a member of NASA's Solar System Exploration Research Virtual Institute (SSERVI).

Use the Regolith Excavation and Soil Mechanics Test System developed under the previous project to measure penetration and excavation forces on a full scale system, and to test a sample capture device.

## U.S. LOCATIONS WORKING ON THIS PROJECT



■ U.S. States With Work

★ **Lead Center:**  
Kennedy Space Center

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## DETAILS FOR TECHNOLOGY 1

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### Technology Title

Icy Regolith Test Bed

### Technology Description

This technology is categorized as a material for ground scientific research or analysis

A test bed developed to measure the mechanical strength of mixtures of icy asteroid regolith, and to test regolith excavation technologies under a relevant environment with control of the temperature and atmospheric pressure.

### Capabilities Provided

The technology will allow engineers to design more efficient regolith excavators and ISRU processing systems for future exploration missions to asteroids and other planetary bodies.

### Potential Applications

Commercial space mining.